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A SURVEY OF THE ZOOCECIDIA ON SPECIES OF HICORIA CAUSED BY PARASITES BELONGING TO THE ERIOPHYIDÆ AND THE ITONIDIDÆ (CECIDOMYIIDÆ).*

BERTRAM W. WELLS.

This paper is primarily an attempt to present adequate descriptions of the types of 30 itonid (cecidomyid) and 2 eriophyid (mite) galls, collected by the writer on hickory leaves. It is believed to contain sufficient new material to warrant its publication in advance of a general survey of N. E. United States zoocecidia, of which it will form a part. The data is based on collections made in Connecticut, Ohio and Kansas, most of the material however, being taken in Ohio.

In addition, those forms (few in number) previously described which have not been seen by the author, have been added, so as to give a character of completeness to the survey of the two groups of galls.

*Contribution from the Botanical Laboratory of the Ohio State University, No. 92.

There are three groups of zoöcecidia occurring on hickory trees:

1. Galls formed by species of Eriophyes (Fam. Eriophyidæ of the Acarina or mites), or an allied genus. Only two are known.

2. Galls induced by species of Phylloxera (Aphididæ of the Hemiptera). Pergande† has presented an excellent survey of these insects accompanied by very satisfactory descriptions of the cecidia formed by them.

3. Galls caused by species of Caryomyia (Itonididæ of the Diptera). Possibly other genera may be represented on the hickories, but according to Felt‡ "most of the hickory leaf galls are probably made by species of Caryomyia, though other midges have been reared from these deformities."

The genus Caryomyia, which undoubtedly occupies an important place in relation to the majority of the galls described in the present paper, will be given special consideration. Felt, to whom American cecidology is heavily indebted for his extensive studies of dipterous cecidozoons, presents the following description of the genus Caryomyia in the same citation as that immediately above.

"Allied to Hormomyia, but differing by the thorax not being greatly produced over the head and by the presence of but 14 antennal segments. The males may have the flagellate antennal segments binodose or cylindric and subsessile and invariably with three low, stout circumfili. The antennal segments of the female are cylindric and with two circumfili; palpi tri- or quadri-articulate; wings rather broad, the third vein joining the costa at or near the wing apex; claws simple, the pulvilli well developed. The ovipositor of the female is short and with minute lobes apically. The genus appears to be confined to hickory leaf galls."

Adult insects not technically known are given the old generic name "Cecidomyia."

These galls as well as similar ones on other kinds of plants arise as the result of some stimulus (the nature of which is still not definitely known) applied by the very young larva to the

†Pergande, T. "North American Phylloxerinae affecting Hicoria and other Trees." Proc. Davenport Acad. Sci. 9:185–271, pls. 1–21. 1903.

‡Felt, E. P. "The Identity of the better known Midge Galls." Ottawa Naturalist, Vol. 25, Nos. 11, 12. 1912.

growing tissue of the immature leaf. Nothing has yet been done on the development of the itonid galls of the hickories, but from studies on very similar types we have reason to believe that the ontogeny of the itonid forms is as follows: The egg is probably deposited superficially (for the ovipositor of the female Caryomyia is short) on the under side of the leaflet; on the upper side in a few cases.

Hyperplasia or excessive cell proliferation results (probably not until after the larva has emerged from the egg) forming at first a saucer-shaped structure, then cup-shaped and finally by the ingrowth of the edges, the gall becomes a closed structure enveloping the larva in a chamber. The distal growth, seldom if ever in the hickory forms, proceeds so far as to obliterate the opening which was so prominent in the very immature cup-shape stage. Hence in practically all galls of this type a minute canal or pore can be demonstrated at the distal end. In Küster's* very serviceable classification of abnormal plant parts, these fall under his "umwallungen" cecidia, a term very succinctly describing their mode of development.

Two of the following described galls have been studied histologically by Cook,† *Caryomyia holotricha* O. S. and *C. tubicola* O. S.

Concerning the problem of the distribution of the galls on the different species of hickory, it is still too early to be able to make any positive assertions. In most of the reports the species of tree has not been given. It is very well known that certain species of galls are found on 2 and 3 species of hickory, but whether they are developed on all indiscriminately is not known. *H. cordiformis* seems to bear much fewer species than *H. ovata* or *H. alba*. In the present list, the report of the gall upon a particular species of tree does not at all imply that it does not occur on others.

Having had the opportunity to give attention to gall collecting in three rather widely separate localities, eastern Connecticut, southern and northern Ohio and eastern Kansas, some observations on the geographical distributions of the hickory itonids are here briefly presented.

*Küster, E. Die Gallen der Pflanzen, Leipzig. 1911.

†Cook, Mel T. "Galls and Insects Producing Them." Ohio Nat. 4:140–141. 1904.

It is sometimes stated that the distribution of gall insects is similar to that of their host plants. In certain cases this does not seem to be true. In that of my number 32 first found and described by Sears, no report of this large and striking form has appeared, showing it to occur east of the Allegheny mountain system, a region in which *H. ovata* is abundant. In the cases of my numbers 5, 9, 19 and 31, all heretofore unreported and possessing prominent distinguishing characters, it would seem as though they were somewhat restricted in their distribution, for while comparatively common in Ohio, they are never seen in Connecticut or Kansas, where equally intensive collecting was prosecuted. So few are the students of cecidia and so meager the data in this field, that it is, however, much too early to make positive assertions in matters of geographic distribution.

The data on the galls presented herewith was compiled for the most part at the time of collection; the notes and drawings made from fresh material. For later comparative work, the material was all preserved in formalin, each collection being assigned to a vial.

The writer has refrained from attaching a specific name to his new species of cecidia, a practice very common on the part of European cecidologists. Even though the adult gall has no direct relation to the adult insect, the fact, nevertheless, remains that the specificity of the gall owes its origin to the specificity of the physiological phenomena of the larval insect, and it is this, which in the mind of the writer, gives pre-eminence to the insect. The adult gall and the adult insect can be conceived as arising from the same complex, the larva, the adult insect bearing, however, a more intimate and direct relation to the original source of events than the gall. In many cases the adult insects offer characters, making possible the delimitation of species, with greater exactness, than do the galls. For these reasons new names of cecidia should only appear with adequate descriptions of the cecidozoons.

Though the galls almost uniformly occur on the under side of the leaflet, the drawings have presented them in an inverted position, with the gall uppermost, this being the position in which the galls would be examined. In practically all cases there are two sketches of the type, one showing the exterior aspect of the gall, the other the interior as seen in a vertical, median section. The figure number is in all cases the same as the list number.

The writer wishes to express his appreciation of the hospitality of his friend, J. L. King, who, as assistant entomologist for the Ohio Experiment Station, shared his field laboratory during some of the time in which cecidological collecting was being carried on.

Though the writer has seen (with a few exceptions) the types herewith detailed an amply sufficient number of times to establish them as types, he does not claim infallibility, for the key he has worked out to these types. It is hoped, however, that it, together with the descriptions and illustrations will enable the student of the hickory galls to become better acquainted with the members of the two groups treated.

Britton and Brown's Illustrated Flora Northern U. S. and Canada, (2nd edition), New York, 1913, has been followed in the matter of plant nomenclature.

The following two galls whose makers have been named by Felt have probably not been seen by the writer. Felt's descriptions are given. They are not included in the key.

Caryomyia thompsoni Felt.
"Globose, thin-walled, long haired, melon-shaped, dia. 2–3 mm."

See my number 23.

Caryomyia antennata Felt.
"Globose, thick-walled, yellowish green or brown. Dia. 4–5 mm."

This description as far as it goes, would indicate a similarity to C. persicoides Beut.

Felt, Jour. Econ. Ent. 4:456. 1911.

Key.

The itonid group of galls herewith presented can be distinguished with one exception (No. 33) from the very common Phylloxera galls (Aphididæ) by the fact that the latter forms which are sufficiently small to be comparable in size to the itonids are intercalated in the leaf blade, i. e. the gall extends more or less prominently from both sides of the leaf. The itonids always give the appearance of an appendicular structure attached to the leaf.

1. Gall on nut. Caryomyia nucicola. (3)
1. Gall on leaf. 2.
2. An apparent elongate enlargement of vein. Cecidomyia cynipsea (?) (4).
2. An inrolled leaf edge. (2).
2. Galls arising from intervenal tissue between veins or immediately adjoining veins; radially symmetric structures with principal axis more or less perpendicular to leaf blade. 3.

3. Galls double-chambered as seen in vertical median section. 4.
3. Galls single chambered. 7.
4. Galls definitely depressed. (5).
4. Galls small, sub-globular. (6).
4. Galls definitely conic. 5.
5. Elongate gall with rounded base in definite visible socket. (7).
5. Shorter gall attached by pedicel from rounded base not articulating with definite socket. 6.
6. Proximal chamber of gall, conic. (5).
6. Proximal chamber of gall, depressed. (8).
7. Galls definitely conic; forms having rounded bases, the distal portion is sufficiently drawn out to place the cecidium under this class. 8.
7. Galls spheric, sub-spheric or depressed. 15.
7. Galls sub-cylindric, 2½-3 times as long as wide. 22.
7. Galls obconic, i. e., part projecting from leaf is flat topped, constricted proximally to the pedicel embedded in the leaf. 25.
7. Blister gall, intercalated in the leaflet, projecting on both sides. Cecidomyia? sp. (33).
8. Small irregular, low, masses of tissue always in axils of principal veins of leaflet. Eriophyes sp. (1).
8. Galls definite structures projecting prominently from leaf surface. 9.
9. Conic gall generally with strongly recurved tip appearing as though lying on side, decumbent. (9).
9. Galls erect or tilted, seldom bent over, however, beyond angle of 45. 10.
10. Gall with flattened sides, pyramid-like. (10).
10. Galls with sides flattened. 11.
11. Proximal half of gall conic, never sub-globular. (11).
11. Proximal half sub-globular. 12.
12. Galls smooth. 13.
12. Galls pubescent. 14.
13. Galls large, 4–7 mm. long. (12).
13. Galls small, 1½–4 mm. long. (13).
14. Trichomes very long coarse. (14).
14. Pubescence short, fine. (15.)
15. Galls attached by proximal pedicel embedded in leaf, as seen in a median vertical section.
15. Galls attached by structure extending from leaf into base of gall, which remains on leaf when gall falls. 20.
16. Walls thick, soft. 17.
16. Walls thin, 18.
17. Galls smooth, depressed or with upward flaring walls forming a saucer or cup-shaped structure distal to the chamber. (16).
17. Gall globular, finely pubescent like that of a peach. (17).
18. Surface perfectly smooth, symmetrically sub-spherical galls. 19.
18. Surface minutely shagreen-roughened, gall asymmetric, one side prominently extended laterally. (18).
19. Small galls, 2½ mm. dia., nipple expanded and flattened resembling the end of a bottle. (19).
19. Larger gall, 3–4 mm. dia., nipple short, pointed. (20).
20. Thick-walled, particularly the distal end, covered with heavy tawny pubescence. (21).
20. Thinner walled, pubescence very short, puberulent. 21.
20. Very smooth. (22).
21. Depressed (not over 3 mm. high) with column extending through center of chamber. (23).
21. Globular, 4–5 mm. high. (24).
21. Definitely balloon-shape. (25).
22. Base embedded in socket. 23.
22. Base not embedded in socket. 24.
23. Round-conic at tip. Caryomyia tubicola. (26).
23. Tapering to point, horn-like. (27).

24. Small gall, 2-2½ mm. high, with flaring base, attached by minute pedicel at center. (28).
24. Large gall, 5-6 mm. long, gradually constricted proximally to very narrow neck at point of attachment. (29).
25. Distal face with fovea containing a central nipple. Leaf not projecting on side opposite gall. (30).
25. Distal face with fovea, leading into central pore; no central nipple. Prominent convexity of leaf on side opposite the gall. (31).
25. Distal face flaring out at edge into radiate bracts; these sometimes strongly incurved. (32).

ERIOPHYIDÆ.

1. **Eriophyes?** sp. **Cecidium** nov.

Small galls in the axils of the lateral veins of the leaflets. Above marked by a light colored angular area 1-1½ mm. dia. Below a small mass of tissue (the gall proper) fills the angle, covered by a fine close pubescence. Chamber within of small diameter, irregular in shape. The characteristic mites were definitely observed. They are white in color. On some leaflets every angle made by the mid-vein branching into the lateral ones was occupied by a gall. On *H. cordiformis*, in Athens County, Ohio, August.

Type specimens at Ohio State University.

2. **Eriophyes?** sp.

Leaf edge gall; edge inrolled involving little more than the teeth. Variable in length from .5-2 cm. or longer, 1 mm.-2 mm. thick. Outer surface of affected area finely roughened; color of under side of the leaf. Thompson states that mites live within the fold. His report is the first one on this gall. Species of hickory on which specimens were found not determined.

Thompson, Illus. Cat. Am. Ins. Galls. 1915. p. 57, pl. 10, Fig. 260.

ITONIDIDÆ.

3. **Caryomyia nucicola,** O. S.

"Irregular swelling in the husk produced by the reddish larvæ. Reference to Caryomyia provisional." Felt. "Contain thick walled cells. On Carya (Hicoria) alba." Jarvis.

Osten Sacken, Trans. Am. Ent. Soc. 3:53. 1870.
Felt, Jour. Econ. Ent. 4:457. 1911.
Jarvis, 39th Ann. Rept. Ent. Soc. Ont. 1908. p. 84.

4. **Cecidomyia cynipsea** O. S.

"Rounded, irregular, hard swelling on the under side of the hickory leaf, on the mid-rib near the base of the leaf about

half an inch long. In July, pale yellowish and contained in several small hollows, minute whitish larvæ, with breast bone narrowed anteriorly and ending in a point." Osten Sacken.

This form is so different from the other itonid galls of the hickory that the writer is inclined to place it here tentatively. It is very similar to *Phylloxera caryævenæ* Fitch, with the exception that the hyperplasia extends below the leaf, while in the phylloxera gall it is developed on the upper side. The writer has observed orange colored larvæ in the aphid galls, but they were not definitely determined to be itonid.

Since this type of gall has not since been reported as definitely caused by itonid larvæ, it is barely possible that Osten Sacken described the empty phylloxera gall above mentioned containing inquilinous itonid larvæ. The writer found many of these galls deserted by the aphids in the middle of July and Pergande states that the aphid nymphs begin to leave the galls in July. At this time, these galls are a "pale yellow" color as described for the "cynipsea" gall. The writer's observations were made in southern Ohio, while Osten Sacken's were made in the vicinity of Washington, D. C.

Osten Sacken, Lowe's Monogr. Dipt. N. Am. Pt. 1. p. 193. 1862.

5. **Cecidomyia** sp.

Leaf, under side, double chambered conic or depressed (Fig. 5a) gall. The latter condition is perhaps the more usual. In these forms, the conic tip is sunken in the central fovea, the gall only measuring from 1½-2 mm. vertical diameter. The conic forms are as though the tip was pulled out destroying the fovea. These often measure 5 mm. in height. The width of the galls varies from 3-5 mm. Very light green, or when older yellow to red, surface roughened with low tubercles as seen with lens. Inner chamber sub-conic with short mucronate tip. Walls of both chambers thin and smooth, outer wall slightly sticky. Base of gall flat, arising from a definite pedicel, resting in a cup-like depression, which is formed in a definite hyperplasia intercalated in the leaf. Above, this hyperplasia is evident as a raised circular area, 2½ mm. diameter, in the center of which is a minute light colored papilla.

Rather common on *H. alba*. Collected in Hocking and Athens counties, Ohio.

This double-chambered gall cannot be *Caryomyia inanis* Felt, for it is neither "globose and small." The author describes elsewhere a specimen which fits that description and is very probably produced by the cecidozoon just mentioned. Absolute certainty, it must be remembered, can only be obtained by checking the reared adult insects with the original descriptions.

Sears described this gall from Cedar Point, Ohio, under the name *C. inanis*.

Sears, Ohio Nat. 15:380, pl. 18, Fig. 18. 1914.

6. **Caryomyia inanis** Felt.

"Globose, thin-walled with a false chamber at the apex. Dia. 2-3 mm." Felt.

In my material, the false chamber is large, occupying more than half of the gall. The gall is slightly balloon-shape, 2½ mm. high. Surface perfectly smooth. Collected, Hocking County, Ohio, on H. ovata.

Sears in his "Insect Galls of Cedar Point (Ohio) and Vicinity," described my number 5 under this species.

Felt, Jour. Econ. Ent. 4:456. 1911.
Felt, Bull. Brooklyn Ent. Soc. 8:99. 1913.

7. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, elongate-conic constricted somewhat at base so as to resemble a miniature lamp chimney. Arises from saucer-like base. 5 mm. in length. Smooth, greenish-yellow to brown. Two chambered, the larval chamber at the proximal end, sub-spherical with a dia. about ⅓ the length of the gall. The distal false chamber large, the walls becoming thin apically. The partition separating the chambers is firm with a minute perforation at its center. Surface of leaf opposite gall not raised.

Collected in Hocking County, Ohio, on *H. glabra*, July.

Type specimens unaccountably missing. The description is nevertheless presented inasmuch as both it and the drawing were made from fresh material in the field.

8. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, a gall similar to 7, perhaps a variety of it, though its prominent and constant differences would indicate a distinct species. Conic with rounded base and truncate tip, 4-6 mm. high, 3-4 mm. broad in widest part. The wall at

the tip thin, splitting into a fimbriate condition. Attached by a minute central pedicel, no trace of a saucer-shaped structure developing around the base. Galls greenish to red and purple tinted. Uniformly being covered with sparsely distributed short hairs. Interiorly two chambered, the larval chamber proximal and occupying nearly one-half of the gall. Walls including the partition comparatively thin. Surface of leaf opposite gall slightly raised with reddish tint.

Collected in Athens County, Ohio, on *H. alba*, August.

Type specimens at Ohio State University.

9. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, elongate conic, asymmetric, the axis lying horizontal or parallel with the leaf blade plane. The tip is invariably strongly recurved upward and backward. The side of the proximal part of the gall lying against the leaf is flattened and rests close against the leaf and vein; the galls always spring from the side of a vein. Size variable from 2 mm. in length to 4 mm. this measurement distally not being made to the tip but merely to that part of the recurved terminal portion, farthest from the base. The larger specimens measure 1½–2 mm. in width at the proximal end. Light green to nearly white, or sometimes roseate tinged. Very smooth. Walls thin distally thickening toward the basal end.

Not uncommon on *H. alba* in Hocking County, Ohio, July.

Type specimens at Ohio State University.

A gall, somewhat similar and probably a variety of the above was collected on *H. glabra*, (Fig. 9a.)

Cylindric-conic, sharply bent over against the leaf, attenuate distal part short, not recurved, 3½ mm. long. Smooth, white like ivory. Wall rather thick, hard. Base of gall in shallow saucer-like depression against the vein. Interiorly the distal end is choked with coarse trichomes.

10. **Cecidomyia** sp. **Cecidium** nov.

Leaf, under side, distal $\frac{2}{3}$ of gall dome-shaped with 3– many triangular sides, the flaring base resting on the proximal, constricted or saucer-shaped $\frac{1}{3}$; 2–3 mm. high, 3–4 mm. wide. Tip attenuate, not sharp pointed, however. Light green to yellowish green, the tip darker, reddish to black. Surface smooth under lens. Larval chamber spherical, surrounded by scler-

enchmya layer. This gall is very distinctive no other forms having the peculiar angular structure which it possesses. Not abundant.

Collected at Gypsum, Ohio, August, on *H. microcarpa*. Type specimens at Ohio State University.

11. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, rather large conic gall, whose distal $\frac{1}{2}$–$\frac{1}{3}$ constitutes a very slender apical process. Through this passes the fine canal leading to the depressed, sub-globular chamber in the proximal part of the gall. The galls are either erect or more generally tilted to one side, always arising from one of the larger veins. 5–8 mm. long, $2\frac{1}{2}$–$3\frac{1}{2}$ mm. wide at base. Outline of the flaring sessile base generally angular. Attenuate distal portion turning dark early. Light greenish yellow to brown when old. Smooth. Walls of chamber thick. A slender probable variety of this is figured in 11a, pl. I.

Collected in Hocking County, Ohio, on *H. alba*. July. Type specimens at Ohio State University.

12. **Caryomyia caryæcola** O. S.

On leaf, under side, large galls with globular basal part extending into a point distally. Shape suggests that of a Prince Rupert's drop. 4–7 mm. long. Surface very smooth, greenish to reddish tinged. Some show a definite blue color over the attenuate apical end. Walls of medium thickness, very firm. Somewhat similar to *C. sanguinolenta* O. S. but differs from that gall in its larger size and much more attenuate distal end. Common on different hickories.

Osten Sacken, Lowe's Mongr. Dip N. Am. Pt. 1, p. 192. 1862.
Felt, Jour. Econ. Ent. 4:456. 1911.

13. **Caryomyia sanguinolenta** O. S.

On leaf, beneath, stoutly conical, varying in size from $1\frac{1}{2}$ mm. to 4 mm. high. Tip erect or often bent to one side. Smooth, green to purplish-red and finally a brown when old. Attached to smaller veins by short pedicel, hidden from view, however, by the rounded base of the gall. Walls medium in thickness, possessing the rather soft texture of charcoal when dry; brown in color.

This form is often found in enormous numbers on certain trees, bringing about early disintegration of the affected leaves.

The lower leaves are more heavily infested due to the fact that the insects are apt to reach these first in their flight from the ground in the spring.

Osten Sacken, Lowe's Monogr. Dip. N. Am. Pt. 1, p. 192. 1862.
Beutenmuller, Am. Mus. Nat. Hist. Guide Leaflet No. 16, p. 28, Fig. 59. Reprint from Am. Mus. Jour. Vol. 4, 1904.

14. **Cecidomyia** sp. **Cecidium** nov.

Leaf, under side, distal half conic-attenuate from the bulbous or sub-globular proximal half. Covered with long, coarse trichomes, the longest being half the length of the gall. Trichomes brown. Tip of gall generally darker than rest. 3–4 mm. high, 2–3 mm. wide. Cavity sub-spherical somewhat depressed at right angles to axis of gall. Walls relatively thick, especially the proximal part. Apical canal evident in median longitudinal section. Gall attached by short and broad pillar of tissue extending from the leaf into the fleshy base.

Gypsum, Ohio, August, on *H. ovata.*

Type specimens at Ohio State University.

15. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, small, conic galls, generally found in pairs closely appressed to each other but not confluent. Distal attenuate $\frac{1}{3}$ rather sharply constricted from the sub-globular $\frac{2}{3}$ of the gall and generally turned to one side. 2 mm. high, 1½–2 mm. broad at base. Yellowish in color, definitely and constantly pubescent. Interiorly the lining of the sub-globular larval chamber is deep blue-black in color. Walls of medium thickness. Comparatively large region of the base involved in the attachment of the gall.

Collected in Hocking County, Ohio, on *H. alba*, July.

Type specimens at Ohio State University.

16. **Cecidomyia** sp.

On leaf, under side, greatly depressed with central, prominent nipple, 3–5 mm. dia. 1½–2½ mm. thick (vertical dia.) not including nipple. Light green, smooth. Firm fleshy with central sub-spherical larval chamber whose wall is differentiated from the surrounding tissue. Apical canal through nipple evident. This gall first reported and illustrated by Thompson.

Thompson, Illus. Cat. Am. Ins. Galls. 1915. p. 56, pl. 13, Fig. 228.

A most interesting variant of this form is illustrated in Fig. 16a. If it were not for the large number of intermediate forms found, this one would easily be considered distinct. The region of the chamber surrounded by thick walls has been much reduced, so that only a circular area about the upper part of the chamber has the thick wall projecting from it. This new condition results in the formation of a definite saucer-shaped structure on the distal end of the gall. In some specimens the structure was no longer saucer-shape, but by the ingrowth of the edges it was assuming a spherical form, developing a two-chambered gall. It is natural to suspect that this may have been the mode of origin of the four-double-chambered galls described elsewhere in this paper. That, however, is entirely problematic.

17. **Caryomyia periscoides** Beut.

On leaf, underside, generally large, sub-globular galls. Younger ones appear like older, both often being found on same leaflet, 4–7 mm. diameter. Galls covered with a fine short yellowish to reddish pubescence, suggesting the texture of peach "bloom." Walls very thick, firm fleshy, surrounding the central spherical cavity, pierced, however, at the distal end by the fine apical canal. Closely sessile on leaf, generally at side of principal vein. Collected on *H. alba, glabra* and *ovata*.

From Felt's short description, *Caryomyia antennata* Felt, must have been taken from a similar gall.

Osten Sacken, Lowe's Mono. Dip. N. Am. Pt. I. p. 193. 1862.
Beutenmuller, Am. Mus. Nat. Hist. Bull. 23:393. 1907.

18. **Cecidomyia** sp.

On leaf, under side, sub-globular (almost uniformly asymmetric in that one side projects laterally so as to present a parabolic outline, rather than a semi-circular one). A short definite nipple terminates the gall. 2–4 mm. diameter. White or light yellow to red. Walls medium in thickness, of a soft, almost fleshy consistency. Exterior surface almost uniformly minutely shagreen-roughened when observed with lens. The constricted base of the gall rests in a shallow saucer-shaped structure.

This gall was described from Connecticut in citation below on *H. ovata*. Rather common in Hocking County, Ohio, on *H. microcarpa*. July, August.

Felt's "Cecidomyia sp. Globose, irregular, ovate, granulate, a slight nipple, dia. 2–3 mm." probably belongs here.

Felt, Jour. Econ. Ent. 4:456. 1911.
Wells, Ohio Nat. 14:291. 1914.

19. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, small, smooth, spherical galls, with a peculiar tip shaped like the end of a bottle, arising abruptly from the globular gall, 2–2½ mm. diameter. The gall reminds one of a miniature bomb. Green to yellowish with dark spots over the distal half. Thin-walled. Attached by a minute obconic pedicel. The pupa in these galls is suspended in the upper part of the chamber by a thread passing from each end of the body to the walls of the chamber. The galls drop from the leaves in late July. Not common.

Collected in Hocking County, Ohio, July, on *H. microcarpa*.

Type specimens at Ohio State University.

20. **Caryomyia caryæ** O. S.

On leaf, under side, sub-spherical gall with more or less prominent apical nipple. 3–3½ mm. diameter, rarely 4 mm. Light green, turning brown, smooth. In many, very definite meridian-like striations can be observed marking the wall. Wall thin, very fragile and dry. Surface of chamber smooth as though polished. Attached by conic pedicel arising from fovea in base of gall. This pedicel with its pointed end attached to the leaf is surrounded by or rests in a cup-like structure. In this respect the gall differs markedly from No. 22, which it superficially very much resembles.

Fig. 20a is a large specimen showing the peculiar interlocking base exceptionally well developed.

Collected from *H. alba* and *H. ovata*, July and August.

Felt, Jour. Econ. Ent. 4:456. 1911.

21. **Caryomyia holotricha** O. S.

On leaf, under side, large tawny, long-haired galls, distributed singly (Fig. 21) or massed (Fig. 21a) on the leaflet. When massed they form a conspicuous brown, hairy structure, suggesting a huge caterpillar. The isolated galls are subglobular to round-conic with or without a small terminal

nipple. 3–5 mm. vertical diameter, 3–5 mm. wide. Interiorly the chamber of the isolated form is depressed, this fact being associated with that of the thick distal wall. Gall chamber surrounded by definite sclerenchyma layer. Cortical tissue firm. Attached by irregular process from leaf extending into base of gall. In the massed forms, the galls are similar in structure, but are variously shaped, due to mutual pressure, (Fig. 21b). Compactly attached to the common central hyperplasia along the vein, which on the upper side of the leaf is a reddish irregular, low elevation. Some of these masses are as long as 5 cm., possessing a thickness of 10–15 mm.

Common on various hickories, particularly *H. ovata*.

A gall which may eventually prove to be a different species but which here is provisionally classed as a variety of *C. holotricha*, was found in numbers on the leaves of *H. alba*, though it is probably not restricted to this species of hickory. Instead of an apical nipple, it has an apical pit, which is choked with the characteristic brown pubescence of this type of gall. Internally a tuft of coarse brown trichomes extends inwardly from the distal side of the chamber. The chamber occupies the proximal one-half to two-thirds of the gall, the wall over it being uniformly very thick. This type of gall is constant, being collected repeatedly and examined minutely.

Based on Felt's brief description, his *Caryomyia thompsoni* Felt was taken from this gall or one very similar to it.

Closely allied to the above variety is another form, with internal tuft of trichomes, in which the apical nipple is present. The layer of tissue lining the chamber appears very white, due probably to the character of the tissue beneath the superficial nutritive layer. In section the thin white chamber wall is very definitely delimited from the adjoining darker tissues. Many of these conic-sub-spheric galls were 6 mm. in width. Collected on *H. glabra*. Types of this and the above variety are at the Ohio State University.

Osten Sacken, Lowe's Monogr. Dip. N. Am. Pt. I, p. 193. 1862.
Felt, "Hormomyia holotricha" 23rd Rept. Ins. N. Y. 1907. pp. 382, 389.
Felt, "Caryomyia holotricha" Jour. Econ. Ent. 4:456. 1911.

22. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, sub-globular with minute apical nipple. Tip of latter truncate with fine pore in center. 3 mm. high, 2½–3 mm. wide. Generally wider through one axis. Smooth;

light greenish yellow. Interiorly a more or less prominent nipple projects inward from the distal end of the chamber, traversed by the apical pore. Toward maturity the interior wall is reddened. Gall attached by a short, cylindric pillar, extending from the leaf into the base of the globular structure. At the end of summer the galls fall from the leaf, leaving this pedicel on the leaf. Galls when found are apt to occur in large numbers, as many as 50–60 commonly being found on a single leaflet.

Collected in Hocking County, Ohio, on *H. microcarpa*, July. Type specimens at Ohio State University.

23. **Cecidomyia** sp. **Cecidium** nov. (?)

Leaf, under side, depressed (door-knob-shape) closely sessile on leaf attached by a very short stout pedicel. 3–4 mm. wide, 2–2½ mm. high. Greenish to dull brown, covered with short, thin pubescence or smooth. Interiorally from both the proximal and distal sides, truncated, conic processes extend inward, meeting in the center. From the end of the upper one numerous, very coarse trichomes radiate into the gall chamber, which are white at first, turning brown. The central tissue and the walls are of a firm, fleshy character. There is commonly a more or less definite fovea, exteriorly at the distal end.

Collected in southern (Hocking County) and northern (Lake County) Ohio on *H. ovata*.

Thompson briefly describes and illustrates a gall similar to the above which Felt as editor called *Caryomia thomsoni*. The illustration, however, shows the gall not be to Felt's *C. thompsoni* as he has described it, viz., "Globose, with long, erect, reddish, fuscous hairs."

Felt, Bull. Brooklyn Ent. Soc. 8:99. 1913.
Thompson, Illus. Cat. Am. Ins. Galls, p. 56, pl. 12, Fig. 227.

24. **Cecidomyia** sp. **Caryomyia similis** Felt (?)

On leaf, under side, large, globular, 4–5 mm. dia. Light yellow-green to brown, surface puberulent. A minute nipple terminates the gall. Walls thin. Attached by a short pillar, over which the basal part of the sphere fits like a cap. Surface of leaf not noticeably raised on side opposite the gall.

Collected on *H. microcarpa* in Ohio and *H. glabra* in Connecticut.

This gall is very close if not identical with *Caryomyia similis* Felt. It differs from his description in that it is not "depressed."

Felt, Jour. Econ. Ent. 4:456. 1911.
Felt, Bull. Brooklyn Ent. Soc. 8:99. 1913.

25. **Cecidomyia** sp.

On leaf, generally on upper side, balloon-shaped gall, 3–5 mm. high, 3–4 mm. wide. Terminal nipple arising from slight apical depression. Greenish-brown or sometimes varying toward a very dark purplish tinge, its peculiar color being very constant and characteristic. The surface is dotted over with short, swollen glandular hairs. Trichomes sometimes projecting slightly from apical pore. Walls very thin. Galls attached to short, stout process of the leaf, to be seen only in median, vertical section. Surface of leaf on side opposite the gall not raised. Never numerous on leaflet. Closely related, if not identical, with *C. caryae* O. S. See No. 20.

Observed on *H. glabra*, in Hocking County, Ohio, July.

26. **Caryomyia tubicola** O. S.

On leaf, under side, cylindrical with rounded distal end standing erect from the cup-like base embedded in the leaf blade. 4–6 mm. high, generally very close to 5 mm. 1 mm. dia. Body of gall, yellow to brown in color, distal end reddish to brown, at length almost black. Basal cup, greenish yellow to dark purple. Cylindrical part of gall smooth as though polished. Gall attached to the cup only at its central basal part. Before the end of summer the tube-like portion breaks away with its enclosed larva. On the side of the leaf opposite the gall its position is indicated merely by a dark discoloration. Very common on different kinds of hickories.

Osten Sacken, Lowe's Monogr. Dip N. Am. Pt. 1, p. 192, 1862.
Felt, Rept. Ins. N. Y. 1907. pp. 382, 388, pl. 37, Fig. 5.
Felt, "Caryomyia tubicola" Jour. Econ. Ent. 4:456. 1911.

27. **Cecidomyia** sp. **Cecidium** nov.

Leaf, under side, arising from a shallow cup-like structure. Shape of a slender horn, slightly curved, 5–7 mm. long, 1¼ mm. wide at base. Light green at base, changing to yellow, the distal ⅔ of the gall a deep brown. No demonstrable opening at the end. Walls thin. Surface smooth, under lens minute longitudinal striations evident. Very little discoloration on the

upper side of the leaf to mark the location of the gall beneath. Resembles *Caryomyia tubicola* O. S. but is certainly a different species.

Collected in Hocking County, Ohio, July, on *H. alba.*

Type specimens at Ohio State University.

28. **Cecidomyia** sp. **Cecidium** nov.

On leaf, generally upper side, delicate, small, sub-cylindric galls, standing erect, 2–2½ mm. high, less than 1 mm. wide, constricted proximally to the slightly flaring base. Distal end marked off by a circular ridge, in the center of which is a rounded nipple. This latter turns dark early. Gall light green, at length turning brown. Arises from intervenal areas between the smaller veins. On the under side of the leaf the gall above is indicated by a minute dark area. Attached to leaf by minute central pedicel.

Collected in Hocking County, Ohio, on *H. alba* in July.

Type specimens at Ohio State University.

29. **Cecidozoon** (Type undetermined.) **Cecidium** nov.

On leaf, under side, rather large, pouch-like gall (5–6 mm. long) arising from a principal vein. Shaped like a stout gourd, it is bent over nearly recumbent against the blade of the leaf. 2–2½ mm. wide. The proximal end is sharply constricted at the minute point of attachment. The walls when collected were light brown in color, sparsely covered with short white hairs. Walls very thin and when dry brittle. Interior surface smooth. Inconspicuous on the upper side of the leaf, except for the minute pore next the vein. Two specimens from the same leaflet.

This gall differs so markedly from all the other cecidomyidous galls of the hickories, that I am not certain just where to place it. They contained no occupants of any kind.

Collected in Hocking County, Ohio, on *H. glabra,* July.

Type specimens at Ohio State University.

30. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, obconic gall resting in firm collar-like base. Somewhat similar to 31, but differs in definite constant characters to make it distinct. Proximal end not rounded but definitely conic, distal broad end with prominent fovea in the

center of which arises a well defined nipple. Dia. across top, 2½ mm., height from leaf surface, 2 mm. Greenish to reddish brown, smooth. No prominence or convexity of leaf surface opposite the gall, a slight discoloration only marking the position of the cecidium.

Collected in Hocking County, Ohio, on *H. microcarpa*, July. Type specimens at Ohio State University.

31. **Cecidomyia** sp. **Cecidium** nov.

On leaf, under side, small, obconic galls which in development appear to burst through the epidermis, for gall is surrounded by the ragged collar-like remnant. The rounded proximal end strongly sunken in the leaf blade which is prominently convex on the opposite side. Distal end truncate with funnel-like depression leading to the rather large apical pore. This latter connects the depressed chamber within with the exterior. Distal broad end 1½ mm. wide. Gall projects from leaf surface 1–1½ mm. Smooth; light greenish-yellow in color. Walls very thick distally, very thin proximally where it is connected to the leaf at the central region. On the upper side of the leaf the low, hemispheric convexity is reddened, particularly toward the periphery. At first it was thought that this gall might be a juvenile form of *H. tubicola*, but later observations have shown it to grow no further in length. It is without doubt distinct and new.

32. **Cecidomyia** sp.

"Leaf-gall on under surface, having the form of a much depressed inverted cone, attached by its apex, and with the free base surrounded by a conspicuous fringe. 3–4 mm. high, 4–5 mm. in diameter. Green to light yellow-green. Huron, July 25. Quite rare and I believe hitherto unreported." Sears.

The author has collected this interesting gall at Gypsum, Ohio, in August. Many of them measured 5 mm., not including the radiate, bract-like processes borne on the flaring rim of the gall. The galls bear an evanescent thin disk of tissue on the distal, central region, which is clear brown in color and bears erect scattered trichomes. The underlying surface of the gall or the outer convex part is perfectly smooth. The origin of the apical, brown disk is problematical; from the material at hand

it appeared as if the rim of the gall had developed by pushing out beneath the original apical tissue. After the disk falls, only a minute dark spot marks the apex of the gall. The surface of the under half of the gall, below the flaring, lacerate rim, is more or less pubescent.

Chamber comparatively large; walls thin.

This very striking gall has thus far only been collected by Mr. Sears and myself, both times in northern Ohio and occurring on *H. ovata*.

Some specimens, all occurring on the same leaf varied in that they were not so depressed (almost sub-hemispheric) and had the rim strongly inturned against the very convex distal half of the gall.

Sears, Ohio Nat. 15:380. 1914.

33. **Cecidomyia?** sp.

On leaf, blister-like, irregularly circular in outline, 2½–3½ mm. diameter, ½ mm. thick. Extends above and below about equally. Sometimes a slight central nipple is formed below Greenish to brownish with discolored margin.

Collected in Vinton County, Ohio, on *H. cordiformis*.

Probably same as Felt's "Leaf blister gall, irregular, dull greenish or black margined with small nipple. Diameter 3mm."

This type of gall is so different from all the other cecidomyid forms that it is doubtful if it is a member of that group. It may possibly be an immature or small Phylloxera gall. The writer found white larvæ within his specimens, but was unable to determine them as cecidomyid larvæ. This gall is thus introduced here, provisionally.

Felt, Jour. Econ. Ent. 4:456. 1911.

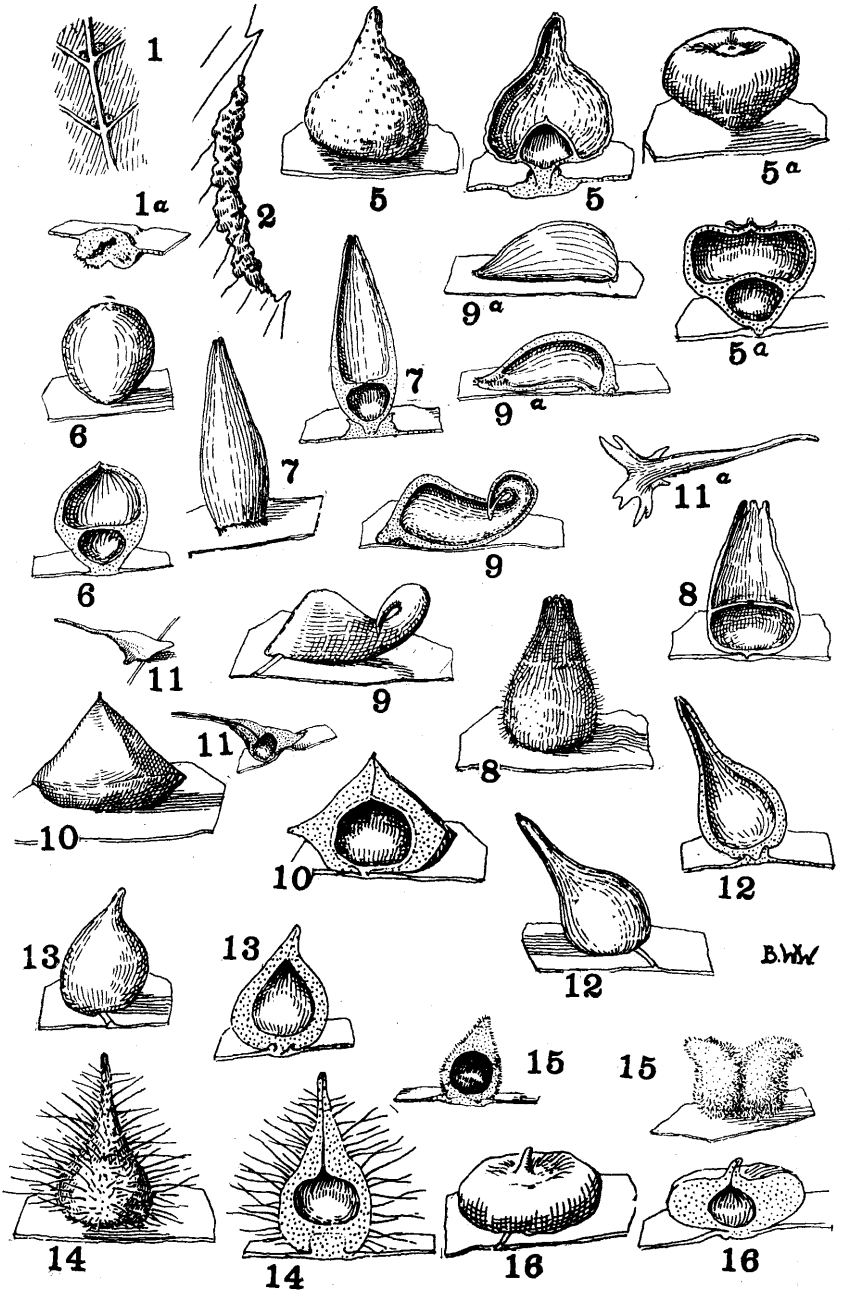
EXPLANATION OF PLATES I AND II.

PLATE I.

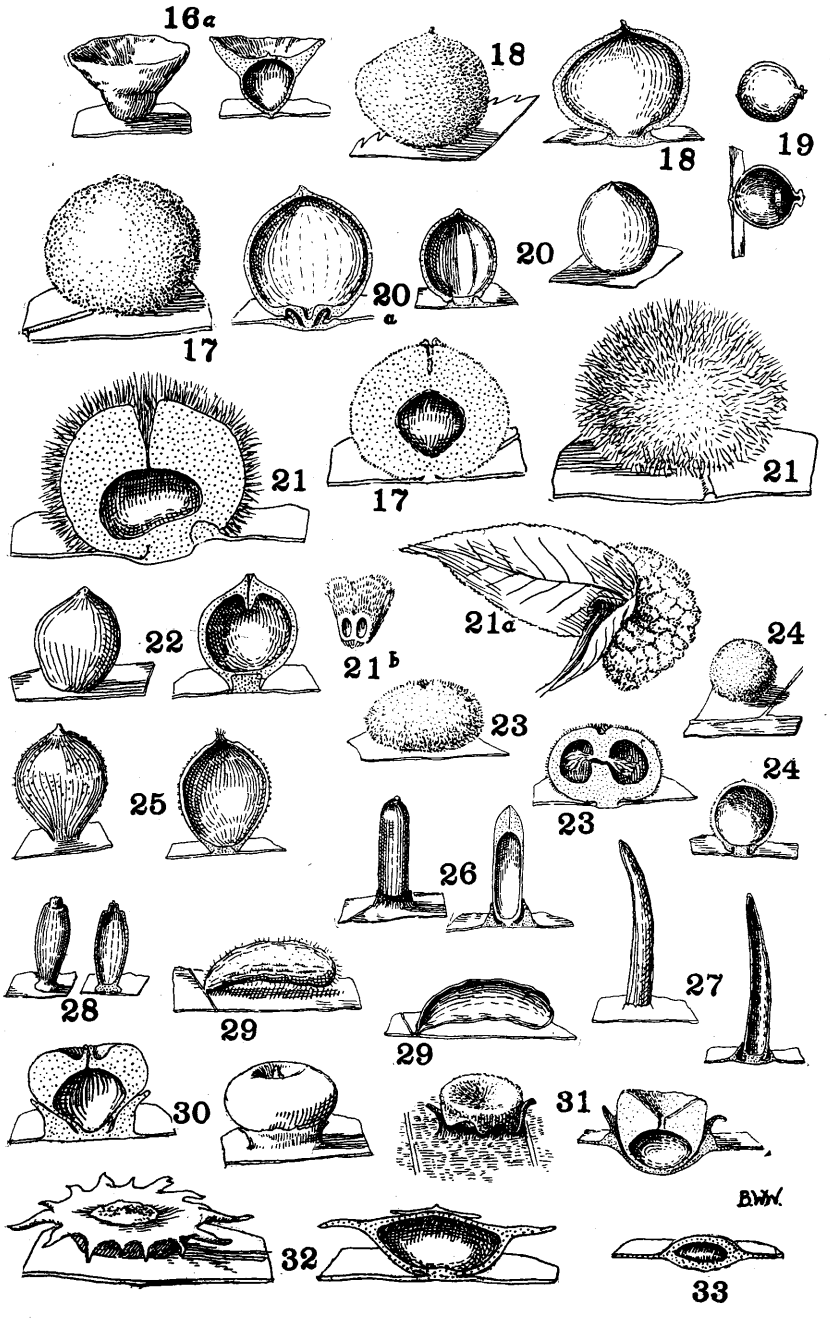
Fig. 1. Mite gall. Eriophyes? sp. × 1⅓.
Fig. 1a. Mite gall. Eriophyes? sp. × 5.
Fig. 2. Mite gall. Eriophyes? sp. × 3.
Fig. 5. Cecidomyia sp. × 4.
Fig. 5a. Cecidomyia sp. Variety. × 4.
Fig. 6. Caryomyia inanis Felt. × 5.
Fig. 7. Cecidomyia sp. New. × 5.
Fig. 8. Cecidomyia sp. New. × 4.
Fig. 9. Cecidomyia sp. New. × 5.
Fig. 9.a Cecidomyia sp. New. Variety. × 5.
Fig. 10. Cecidomyia sp. New. × 5.
Fig. 11. Cecidomyia sp. New. × 1⅓.
Fig. 11a. Cecidomyia sp. New. Variety? × 5.
Fig. 12. Caryomyia caryaecola O. S. × 3.
Fig. 13. Caryomyia sanguinolenta O. S. × 5.
Fig. 14. Cecidomyia sp. New. × 5.
Fig. 15. Cecidomyia sp. New. × 5.
Fig. 16. Cecidomyia sp. × 5.

PLATE II.

Fig. 16a. Cecidomyia sp. Variety, new. × 5.
Fig. 17. Caryomyia persicoides. Beut. × 5.
Fig. 18. Cecidomyia sp. × 4.
Fig. 19. Cecidomyia sp. New. × 4.
Fig. 20. Caryomyia caryae O. S. × 5.
Fig. 20a. Caryomyia caryae. Large specimen. × 5.
Fig. 21. Caryomyia holotricha O. S. Isolated specimen. × 5.
Fig. 21a. Caryomyia holotricha O. S. Aggregate condition × ⅔.
Fig. 21b. Caryomyia holotricha O. S. Bilocular unit of aggregate form. ×2.
Fig. 22. Cecidomyia sp. New. × 5.
Fig. 23. Cecidomyia sp. Possibly new. × 5.
Fig. 24. Caryomyia similis Felt (?) × 1.
Fig. 25. Cecidomyia sp. Caryomyia caryae O. S. (?) × 5.
Fig. 26. Caryomyia tubicola O. S. × 3.
Fig. 27. Cecidomyia sp. New. × 3.
Fig. 28. Cecidomyia sp. New. × 5.
Fig. 29. Cecidozoon (undetermined). New. × 3.
Fig. 30. Cecidomyia sp. New. × 7.
Fig. 31. Cecidomyia sp. New. × 6.
Fig. 32. Cecidomyia sp. × 5.
Fig. 33. Cecidomyia ? sp. × 5.



Bertram W. Wells.



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